403293

FOR RELEASE AT 4"00 P M /E S T /

TUESDAY CMA FEBRUARY 15 CMA 1955

A REPORT

BY THE UNITED STATES ATOMIC ENERGY COMMISSION

ON THE EFFECTS OF HIGH-YIELD NUCLEAR EXPLOSIONS

1. CONSIDERABLE INFORMATION ON THE EFFECTS OF THE EXPLOSIONS OF ATOMIC WEAPONS HAS BEEN MADE PUBLIC BY THE GOVERNMENT SINCE THE FIRST NUCLEAR DETONATIONS IN 1945 PD THE HANDBOOK CMA "THE EFFECTS OF ATOMIC WEAPONS" CMA PUBLISHED IN 1950 CMA IS BEING REVISED AND BROUGHT UP TO DATE TO INCLUDE THE EFFECTS OF THERMONUCLEAR WEAPONS CMA AS A RESULT OF THE MOST RECENT TESTS AT THE PACIFIC PROVING GROUNDS PD REFERENCES TO THE EFFECTS OF THERMONUCLEAR EXPLOSIONS HAVE BEEN MADE IN SEVERAL OFFICIAL STATEMENTS CMA BEGINNING WITH CHAIRMAN STRAUSS" DESCRIPTION OF THE PHENOMENON OF "FALL-OUT" AT A WHITE HOUSE CONFERENCE ON MARCH 31 CMA 1954 PD THE FOLLOWING STATEMENT IS DESIGNED TO CONDENSE AND CORRELATE INFORMATION CMA SOME OF WHICH ALREADY HAS BEEN MADE PUBLIC AND OTHER PORTIONS OF WHICH HAVE BEEN OF A CLASSIFIED NATURE UNTIL NOW PD

2. THE EFFECTS OF NUCLEAR TESTS ARE EVALUATED FOR CIVIL DEFENSE PLANNING AS WELL AS FOR MILITARY AND TECHNOLOGICAL PURPOSES PD SO LONG AS NUCLEAR WEAPONS ARE IN POSSESSION OF ANY UNFRIENDLY POWER CMA THE COMMISSION BELIEVES THE AMERICAN PUBLIC WILL WISH TO BE AS FULLY INFORMED AS POSSIBLE AS TO THE NATURE AND EXTENT OF THE DANGERS OF NUCLEAR ATTACK AND OF THE PROTECTIVE MEASURES THAT CAN BE TAKEN BY INDIVIDUALS AND COMMUNITIES TO AVOID OR MINIMIZE THOSE DANGERS IF WE SHOULD BE ATTACKED PD

3. TEST CONDITIONS CMA WHICH MUST NECESSARILY FORM THE PRICIPAL BASIS OF EVALUATING THE EFFECTS OF NUCLEAR EXPLOSIONS CMA MAY DIFFER MARKEDLY FROM THOSE WHICH MIGHT BE EXPECTED IF NUCLEAR WEAPONS WERE USED AGAINST OUR POPULATION

END OF PAGE ONE OF REPORT

47

IN WARTIME PD IT WOULD BE DIFFICULT TO PREDICT THE SIZE OR KIND OF BOMB AN ENEMY MIGHT USE AGAINST US IN EVENT OF WAR CMA THE EXACT MEANS OF ITS DELIVERY CMA THE HEIGHT AT WHICH IT WOULD BE EXPLODED CMA OR THE NUMBER OF BOMBS WHICH MIGHT REACH A GIVEN TARGET PD NEVERTHELESS CMA THE FACTS TO FOLLOW ARE THE FUNDAMENTAL ONES AT THIS TIME PD

FOUR EFFECTS OF DETONATION

4. A NUCLEAR DETONATION PRODUCES FOUR MAJOR CHARACTERISTICS-- BLAST CMA HEAT CMA IMMEDIATE NUCLEAR RADIATION CMA AND RESIDUAL RADIOACTIVITY PD OF THESE CMA THE FIRST THREE ARE ESSENTIALLY INSTANEOUS CMA WHILE THE FOURTH HAS A MORE PROTRACTED EFFECT PD THE PHENOMENA OF BLAST CMA HEAT CMA AND NUCLEAR RADIATION FROM THE DETONATION OF A THERMONUCLEAR BOMB ARE OF THE SAME NATURE AS THOSE OF EARLIER AND SMALLER ATOMIC BOMBS PD THE NATURE OF THE PHENOMENA IS CMA IN GENERAL TERMS CMA STANDARDIZED WHETHER THE BOMB BE A 20 000-TON /TNT EQUIVALENT/ ATOMIC WEAPON OR A THERMONUCLEAR ONE OF MANY TIMES THAT POWER PD THE INTENSITY AND AREA OF THE BLAST CMA HEAT CMA AND NUCLEAR RADIATION INCREASE IN RELATION TO THE GREATER ENERGY YIELD OF THE EXPLOSION PD INFORMATION ON THESE EFFECTS HAS BEEN EXTENSIVELY PUBLICIZED SMCLN THEREFORE CMA THE REMAINDER OF THIS REPORT DEALS PRINCIPALLY WITH EFFECTS OTHER THAN HEAT AND BLAST PD NYOO

5. RESIDUAL RADIOACTIVITY CMA ALTHOUGH IN NO SENSE EXCLUSIVE TO HIGH-YIELD THERMONUCLEAR DETONATIONS CMA DOES BECOME A MATTER OF MAJOR CONCERN WHEN A LARGE THERMONUCLEAR DEVISE OF THE TYPE USED IN THE 1954 TESTS IN THE PACIFIC IS EXPLODED PD THE FALLOUT OF RADIOACTIVITY FROM SUCH AN EXPLOSION CMA MAY CMA UNDER CERTAIN CONDITIONS CMA SETTLE OVER WIDE AREAS PD THEREFORE CMA THE EXTENT AND SEVERITY OF THIS RADIOACTIVE FALLOUT HAS BEEN A SUBJECT OF

CONTINUING STUDY SINCE THE FIRST FULL-SCALE THERMONUCLEAR TESTS AT THE PACIFIC PROVING GROUNDS ON NOVEMBER 1 CMA 1952 PD THE RESULTS OF THESE STUDIES AND OF OUR EVALUATION OF DATA OBTAINED FROM THE LATEST TESTS IN THE PACIFIC IN MARCH CMA 1954 CMA ARE DESCIBED IN SUBSEQUENT PARTS OF THIS REPORT PD

6. IT SHOULD BE NOTED THAT IF WE HAD NOT CONDUCTED THE FULL-SCALE THERMONUCLEAR TESTS MENTIONED ABOVE CMA WE WOULD HAVE BEEN IN IGNORANCE OF THE EXTENT OF THE EFFECTS OF RADIOACTIVE FALLOA AND CMA THEREFORE CMA WE WOULD HAVE BEEN MUCH MORE VULNERABLE TO THE DANGERS FROM FALLOUT IN THE EVENT AN ENEMY SHOULD RESORT TO RADIOLOGICAL WARFARE AGAINST US PD

END OF PAGE 2 REPORT

PAGE 3

BLAST AND HEAT EFFECTS NYOO

7 THE EFFECTS OF BLAST AND HEAT FROM A NUCLEAR EXPLOSION ARE RELATIVELY LOCALIZED PD ONE A-BOMB OF THE EARLIEST TYPE EQUIVALENT TO 20 000 TONS OF TNT /20 KILOTONS/ WOULD PRODUCE BLAST SUFFICIENT TO DESTROY OR DAMAGE SEVERELY RESIDENCES WITHIN A RADIUS OF MORE THAN ONE MILE FROM THE POINT OF BURST PD WITHIN A RADIUS OF ABOUT A MILE AND A HALF CMA RESIDENCES WOULD BE SO DAMAGED AS TO BE UNUSABLE WITHOUT REPAIRS PD A PRINCIPAL HAZARD TO HUMAN BEINGS WOULD COME FROM FLYING AND FALLING DEBRIS AND FROM FIRES DUE TO SUCH CAUSES AS BROKEN GAS AND ELECTRIC LINES OR OVERTURNED

STOVES PD THE AREA IN WHICH INJURIES TO HUMAN BEINGS WOULD BE CAUSED BY BLAST CMA THERFORE CMA WOULD BE ABOUT THE SAME AS THE AREA OF DAMAGE TO STRUCTURES PD

8. THE UNITED STATES CMA AS ANNOUNCED PREVIOUSLY CMA HAS DEVELOPED FISSION BOMBS MANY TIMES AS POWERFUL AS THE FIRST A-BOMBS CMA AND HYDROGEN WEAPONS IN THE RANGES OF MILLIONS OF TONS /MEGATONS/ OF TNT EQUIVALENT PD FOR THESE LARGER WEAPONS CMA THE BLAST EFFECTS CAN BE CALCULATED APPROXIMATELY BY MEANS OF A SCALING LAW CMA NAMELY CMA THE DISTANCE AT WHICH A GIVEN BLAST INTENSITY IS PRODUCED VARIES AS THE CUBE ROOTS OF THE YIELDS OF THE EXPLOSIONS PD

9. SIMILARLY CMA THE HEAT AND BURN EFFECTS OF NUCLEAR EXPLOSIONS CAN BE ESTIMATED FROM ACCUMULATED DATA PD THESE EFFECTS CMA AXX OF COURSE CMA ARE INFLUENECED BY PREVAILING ATMOSPHERIC CONDITIONS PD THE TIME ELEMENT ALSO IS A PRIME FACTOR PD VERY LARGE WEAPONS DELIVER HEAT OVER AN APPRECIABLY GREATER PERIOD OF TIME THAN SMALLER WEAPONS PD A GIVEN QUANTITY OF HEAT FROM A HIGH-YIELD WEAPON CMA DELIVERED OVER A LONGER PERIOD OF TIME CMA WILL PRODUCE SOMEWHAT LESS SEVERE BURNS THEN THE SAME QUANTITY OF HEAT FROM A NOMINAL DETONATION PD

PROTECTION AGAINST BLAST AND HEAT

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10. THE HAZARD FROM BOTH BURN AND BLAST EFFECTS IN THE OUTER AFFECTED AREAS WOULD BE REDUCED GREATLY BY SHELTER PD CLOTHING R ALMOST ANY KIND OF SHELTER WOULD REDUCE THE DANGER OF DIRECT BURNS CMA ALTHOUGHT THERE MIGHT BE SOME DANGER OF CLOTHING AND STRUCTURE BECOMING IGNITED PD ALSO CMA SHELTER WOULD MATERIALLY REDUCE THE HAZARD OF BLAST INJURY BY AFFORDING PROTECTION AGAINST FLYING OR FALLING DEBRIS PD THE FEDERAL CIVIL DEFENSE ADMINISTRATION HAS MADE EXTENSIVE STUDIES OF SHELTERS AND HAS ISSUED PLANS FOR SEVERAL SIMPLE

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CCC UNDER 10 LINE 3 GR 1 SHD BE OR RPT OR

END OF PAGE 3 REPORT

AND INEXPENSIVE TYPES WHICH CAN BE UTILIZED BY HOUSEHOLDERS PD
AS IS GENERALLY KNOWN CMA THE SHELTER AFFORDED BY ORDINARY CITY
BUILDINGS WOULD NOT SUFFICE WITHIN THE CENTRAL AREA SURROUNDING THE
POINT OF BURST OF A LARGER NUCLEAR WEAPON PD FOR THIS REASON CMA THE
FEDERAL CIVIL DEFENSE ADMINISTRATION RECOMMENDS EVACUATION OF THE
CENTRAL AREAS OF TARGET ZONES ON EARLY WARNING OF APPROACHING ATTACK PD

RADIATION EFFECTS

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11. THE IMMEDIATE NUCLEAR RADIATION CMA I E CMA THE NEUTRONS
AND GAMMA RAYS RELEASED INSTANEOUSLY WITH THE EXPLOSION OF A LARGER
WEAPON ON OR NEAR THE GROUND CMA DOES NOT PRESENT A SERIOUS HAZARD
BEYOND THE AREA WHERE HEAT AND BALST ARE OF GREAT CONCERN PD

FALLOUT RADIATION

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12. HOWEVER CMA PARTICLES WITH RESIDUAL RADIOACTIVITY PRODUCED
BY A DETONATION /AS OPPOSED TO THE IMMEDIATE NUCLEAR RADIATION/
MAY FALL OUT OVER AN AREA MUCH LARGER THAN THAT AFFECTED BY BLAST
AND HEAT CMA AND OVER A LONGER PERIOD OF TIME PD ALL NUCLEAR DETONA-
TIONS PRODUCE RADIOACTIVE MATERIALS CMA BUT THE NATURE AND EXTENT
OF THE RADIOACTIVE FALLOUT DEPENDS ON THE CONDITIONS UNDER WHICH THE
BOMB IS FIRED PD THE MAIN RADIOACTIVITY OF A BOMB"S FALLOUT DECREASES
VERY RAPIDLY WITH TIME-- FOR THE MOST PART CMA WITHIN THE FIRST
HOURS AFTER THE DETONATION PD

FALLOUT FROM IN-THE-AIR DETONATIONS

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13. IN AN IN-THE -AIR EXPLOSIONS WHERE THE FIREBALL DOES NOT TOUCH THE EARTH"S SURFACE CMA THE RADIOACTIVITY PRODUCED IN THE BOMB CONDENSES ONLY ON SOLID PARTICLES FROM THE BOMB CASING ITSELF AND THE DUST WHICH HAPPENS TO BE IN THE AIR PD IN THE ABSENCE OF MATERIAL DRAWN B FROM THE SURFACE CMA THESE SUBSTANCES WILL CONDENSE WITH THE VAPORS FROM THE BOMB AND AIR DUST TO FORM ONLY THE SMALLEST PARTICLES PD THESE MINUTE SUBSTANCES MAY SETTLE TO THE SURFACE OVER A VERY WIDE AREA -- PROBABLY SPREADING AROUND THE WORLD-- OVER A PERIOD OF DAYS CMA OR EVEN MONTHS PD BUT THEY DESCEN EXTREMELY SLOWLY WITH THE RESULT THAT CMA BY THE TIME THEY HAVE REACHED THE EARTH"S SURFACE CMA THE MAJOR PART OF THEIR

END PAGE 4 REPORT
CORRECTIONS 8TH LINE FROM BOTTOM LAST WORD SHLD BE UP RPT UP
THIRD LINE FROM BOTTOM 9 TH WORD SHLD BE DESCEND RPT SESCENDXXX DESCEND

PAGE 5

RADIOACTIVITY HAS BEEN DISSIPATED HARMLESSLY IN THE ATMOSPHERE CMA AND THE RESIDUAL CONTAMINATION IS WIDELY DISPERSED PD

FALLOUT FROM SURFACE DETONATIONS NYOO

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14. IF CMA HOWEVER CMA THE WEAPON IS DETONATED ON THE SURFACE OR CLOSE ENOUGH SO THAT THE FIREBALL TOUCHES THE SURFACE CMA THEN LARGE AMOUNTS OF MATERIAL WILL BE DRAWN UP INTO THE BOMB CLOUD PD MANY OF THE PARTICLES THUS FORMED ARE HEAVY ENOUGH TO DESCENT RAPIDLY WHILE STILL INTENSELY RADIOACTIVE PD THE RESULT IS A COMPARATIVELY

LOCALIZED AREA OF EXTREME RAIOACTIVE CONTAMINATION AND A MUCH LARGER AREA OF SOME HAZARD PD INSTEAD OF WAFTING DOWN SLOWLY OVER A VAST AREA CMA THE LARGER AND HEAVIER PARTICLES FALL RAPIDLY BEFORE THERE HAS BEEN AN OPPORTUNITY FOR THEM TO DECAY HARMLESSLY IN THE ATMOSPHERE AND BEFORE THE WINDS HAVE HAD AN OPPORTUNITY TO SCATTER THEM PD

15. THE AREA OF HAZARD FROM RADIOACTIVE FALLOUT FROM A SURFACE OR NEAR-SURFACE EXPLOSION OF A THERMONUCLEAR WEAPON IS MUCH LARGER THAN THE AREAS SERIOUSLY AFFECTED BY HEAT AND BLAST PD THE LARGE RADIOACTIVE CLOUD OF A THERMONUCLEAR EXPLOSION RISES WITH GREAT RAPIDITY TO THE HIGHEST LEVELS OF THE ATMOSPHERE AND SPREADS OVER HUNDREDS OF SQUARE MILES IN THE FIRST HOURS PD DURING THIS TIME THE WINDS TOSS THE EXTREMELY RADIOACTIVE PARTICLES ABOUT AND THE PATTERN OF THE
RADIOACTIVE FALLOUT IS DETERMINED BY THE SIZE OF THE PARTICLES AND BY THE DIRECTION AND VELOCITIES OF THE WINDS CMA INCLUDING THOSE UP TO 80 000 FEET AND ABOVE PD THE NATURE OF THE SURFACE OF THE EARTH ON WHICH THE BOMB IS FIRED ALSO MUST BE TAKEN INTO CONSIDERATION DP BECAUSE OF THESE VARIABLES CMA IT IS IMPOSSIBLE TO APPLY A SINGLE FALL-OUT PATTERN TO ALL THERMONUCLEAR DETONATIONS CMA EVEN TEST EXPLOSIONS CONDUCTED UNDER SELECTED CONDITIONS PD HOWEVER CMA WITH ADEQUATE KNOWLEDGE OF ATMOSPHERIC CONDITIONS CMA INCLUDING WIND DIRECTIONS AND VELOCITIES UP TO HIGH LEVELS AND METEOROLOGICAL REPORTS CMA THE FALLOUT REGION FOR ANY DETONATION USUALLY CAN BE PREDICATED WITH CONSIDERABLE ACCURACY PD IN GENERAL TERMS CMA THE REGION OF SEVERE FALLOUT CONTAMINATION FRON THE DETONATION OF A THERMONUCLEAR WEAPON FIRED ON OR NEAR THE SURFACE CAN BE DESCRIBED AS AN ELONGATED CMA CIGAR-SHAPED AREA EXTENDING DOWN-WIND FROM THE POINT OF BURST PD

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END OF PAGE 5

FALLOUT PATTERN OF 1954 TEST IN THE PACIFIC

16.THE VERY LARGE THERMONUCLEAR DEVICE FIRED AT THE BIKINI ATOLL ON MARCH 1 CMA 1954 CMA WAS EXPLODED ON A CORAL ISLAND CMA CORAL CONSISTS OF CALCIUM CARBONATE CMA THUS THE DETONATION RADIO-ACTIVITY WAS SPREAD BY PARTICLES CONSISTING LARGELY OF UNSLAKED LIME WHICH CMA DURING THE HOURS OF DESCENT CMA WAS SLAKED BY MOISTURE IN THE ATMOSPHERE PD THESE PARTICLES RANGED BETWEEN 1/1000TH AND 1/50TH OF AN INCH IN DIAMETER AND WERE CMA ON THE AVERAGE CMA SOMEWHAT ADHESIVE PD THE PREVAILING WERE WESTERLY SO THE BOME CLOUD MOVED GENERALLY TO THE EAST AND DEPOSITED THE RADIOACTIVE PARTICLES IN VARYING AMOUNTS OVER AN ELLIPTICAL OR CIGAR-SHAPED AREA PD ABOUT 160 /STATUE/ MILES DOWN-WIND FROM THE POINT OF BURST THE EARLY FALLOUT WAS OBSERVED IN THE FORM OF FINE PARTICLES WHICH LOOKED LIKE SNOW PD FALLOUT BEGAN THERE ABOUT EIGHT HOURS AFTER THE DETONATION AND CONTINUED FOR SEVERAL HOURS PD

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17. THE ROENTGEN IS THE COMMONLY ACCEPTED UNIT OF MEASUREMENT OF RADIATION DOSAGE PD A DOSE OF ABOUT 25 ROENTGENS OF RADIO-ACTIVITY RECEIVED BY A PERSON OVER A BRIEF SPACE OF TIME WILL PRODUCE TEMPORARY CHANGES IN THE BLOOD PD A DOSE OF SOME 100 ROENTGENS RECEIVED IN A SHORT INTERVAL MAY PRODUCE NAUSEA AND OTHER SYMPTOMS OF RADIATION SICKNESS PD ABOUT 450 ROENTGENS DELIVERED OVER A DAY OR SO MIGHT BE FATAL TO APPROXIMATELY HALF OF THE PERSONS SO EXPOSED PD HOWEVER CMA BECAUSE OF THE BODY"S REPAIR PROCESSES CMA A TOTAL RADIATION DOSE WHICH WOULD BE SERIOUS IF INCURRED IN A FEW MINUTES WOULD PRODUCE MUCH LESS EFFECT IF SPREAD OVER A PERIOD OF YEARS PD THESE STATEMENTS MAY BE HELPFUL IN UNDERSTANDING THE DATA WHICH FOLLOW PD

18. THE TEST EXPLOSION CMA AT GROUND SURFACE CMA CONTAMINATED A CIGAR-SHAPED AREA EXTENDING APPROXIMATELY 220 STATUE MILES DOWN-WIND AND VARYING IN WIDTH UP TO 40 MILES PD IN ADDITION CMA THERE WAS A CONTAMINATED AREA UP-WIND AND CROSS-WIND EXTENDING POSSIBLY 20 MILES FROM THE POINT OF DETONATION PD DATA WAS COLLECTED FROM 25 POINTS ON 5 ATOLLS LOCATED FROM 10 TO 330 MILES DOWN-WIND /GENERALLY EAST/ FROM BIKINI ATOLL PD DUE TO AN UNEXPECTED SHIFT IN THE DIRECTION OF THE PREVAILING WINDS IN THE HIGHER ALTITUDES CMA THE FALLOUT MISSED THE OBSERVATION RAFTS THAT HAD BEEN PLACED FARTHER NORTH PREVIOUS TO THE TEST FIRING PD THE ESTIMATED CONTOUR OF THE PATTERN OF FALLOUT IS CMA THEREFORE CMA BASED ONLY IN PART ON DATA OBTAINED FROM ACTUAL MEASUREMENTS AND PARTLY ON EXTRAPOLATION CMA I E CMA CALCULATIONS BASED ON KNOWN DATA CMA INCLUDING FACTUAL INFORMATION OBTAINED DURING PREVIOUS TESTS OF SMALLER DEVICES PD

END OF PAGE 6

19. DATA FROM THIS TEST PERMITS ESTIMATES OF CASUALTIES WHICH WOULD HAVE BEEN SUFFERED WITHIN THIS CONTAMINATED AREA IF IT HAD BEEN POPULATED PD THESE ESTIMATES ASSUME CLN /1/ THAT THE PEOPLE IN THE AREA WOULD IGNORE EVEN THE MOST ELEMENTARY PRECAUATIONS SEMICLN /2/ THAT THEY WOULD NOT TAKE SHELTER BUT WOULD REMAIN OUT OF DOORS COMPLETELY EXPOSED FOR ABOUT 36 HOURS SEMICLN AND /3/ THAT IN CONSEQUENCE THEY WOULD RECEIVE THE MAXIMUM EXPOSURE PD THEREFORE CMA IT WILL BE RECOGNIZED THAT THE ESTIMATES WHICH FOLLOW ARE WHAT MIGHT BE TERMED EXTREME ESTIMATES SINCE THEY ASSUME THE WORST POSSIBLE CONDITIONS PD

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20. ON THE BASIS OF OUR DATA FROM THIS AND OTHER TESTS CMA IT IS ESTIMATED THAT CMA FOLLOWING THE TEST EXPLOSION ON MARCH 1 CMA 1954 THERE WAS SUFFICIENT RADIOACTIVITY IN A DOWN-WIND BELT

ABOUT 140 MILES IN LENGTH AND OF VARYING WIDTH UP TO 20 MILES TO HAVE SERIOUSLY THREATENED THE LIVES OF NEARLY ALL PERSONS IN THE AREA WHO DID NOT TAKE PROTECTIVE MEASURES PD DURING THE ACTUAL TESTS CMA OF COURSE CMA THERE WERE NO PEOPLE IN THIS ZONE PD INSIDE BIKINI ATOLL AT A POINT 10 MILES DOWN-WIND FROM THE EXPLOSION IT IS ESTIMATED THAT THE RADIATION DOSAGE WAS ABOUT 5000 ROENTGENS FOR THE FIRST 36 HOUR PERIOD AFTER THE FALLOUT PD THE HIGHEST RADIATION MEASUREMENT OUTSIDE OF BIKINI ATOLL INDICATED A DOSAGE OF 2300 ROENTGENS FOR THE SAME PERIOD PD THIS WAS IN THE NORTHWESTERN PART OF THE RONGELAP ATOLL CMA ABOUT 100 MILES FROM THE POINT OF DETONATION PD ADDITIONAL MEASUREMENTS IN RONGELAP ATOLL INDICATED DOSAGES CMA FOR THE FIRST 36 HOUR PERIOD CMA OF 2000 ROENTGENS AT 110 MILES CMA 1000 ROENTGENS AT 125 MILES CMA AND CMA FARTHER SOUTH CMA ONLY 150 ROENTGENS AT 115 MILES FROM BIKINI PD

21. SOME DISTANCE FARTHER FROM THE POINT OF DETONATION CMA AT ABOUT 160 MILES DOWN-WIND AND ALONG THE AXIS OF THE ELLIPSE CMA THE AMOUNT OF RADIOACTIVITY WOULD HAVE SERIOUSLY THREATENED THE LIVES OF ABOUT ONE-HALF OF THE PERSONS IN THE AREA WHO FAILED TO TAKE PROTECTIVE MEASURES PD IT IS ESTIMATED THAT THE RADIATION DOSAGE AT THAT POINT WAS ABOUT 500 ROENTGENS FOR THE FIRST 36 HOUR PERIOD PD

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22. NEAR THE OUTER EDGE OF THE CIGAR-SHAPED AREA CMA OR APPROXIMATELY 190 MILES DOWN-WIND CMA IT IS ESTIMATED THAT THE LEVEL OF RADIOACTIVITY WOULD HAVE BEEN SUFFICIENT TO HAVE SERIOUSLY THREATENED THE LIVES OF 5 TO 10 PERCENT OF ANY PERSONS WHO MIGHT HAVE REMAINED EXPOSED OUT OF DOORS FOR THE FIRST 36 HOURS PD IN THIS AREA THE RADIATION DOSAGE IS ESTIMATED AT ABOUT 300 ROENTGENS FOR THE FIRST 36 HOUR PERIOD PD

END PAGE 7

PAGE 8

23. THUS CMA ABOUT 7000 SQUARE MILES OF TERRITORY DOWN-WIND FROM THE POINT OF BURST WAS SO CONTAMINATED THAT SURVIVAL MIGHT HAVE DEPENDED UPON PROMPT EVACUATION OF THE AREA OR UPON TAKING SHELTER AND OTHER PROTECTIVE MEASURES PD

24. AT A DISTANCE OF 220 MILES OR MORE DOWN-WIND CMA IT IS UNLIKELY THAT ANY DEATHS WOULD HAVE OCCURRED FROM RADIOACTIVITY EVEN IF PERSONS THERE HAD REMAINED EXPOSED UP TO 48 HOURS AND HAD TAKEN NO SAFETY MEASURES PD

25. THE ESTIMATES CITED ABOVE DO NOT APPLY UNIFORMLY THROUGH-OUT THE CONTAMINATED AREA INASMUCH AS THE INTENSITY OF RADIOACTIVITY WITHIN A REGION OF HEAVY FALLOUT WILL VARY FROM PIONT TO POINT DUE TO SUCH FACTORS AS AIR CURRENTS CMA RAIN CMA SNOW CMA AND OTHER ATMOSPHERIC CONDITIONS PD BECAUSE OF THIS AND BECAUSE MOST PERSONS CMA IF GIVEN SUFFICIENT WARNING CMA PROBABLY WOULD EVACUATE THE AREA OR TAKE SHELTER AND OTHER PRECAUTIONARY MEASURES CMA THE ACTUAL PERCENTAGE OF DEATHS COULD REASONABLY BE PRESUMED TO BE CONSIDERABLY SMALLER THAN THESE EXTREME ESTIMATES PD

PROTECTION AGAINST FALLOUT

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26. IN AN AREA OF HEAVY FALLOUT THE GREATEST RADIOLOGICAL HAZARD IS THAT OF EXPOSURE TO EXTERNAL RADIATION PD SIMPLE PRE-CAUTIONARY MEASURES CAN GREATLY REDUCE THE HAZARD TO LIFE PD EXPOSURE CAN BE REDUCED BY TAKING SHELTER AND BY UTILIZING SIMPLE DECON-

TAMINATION MEASURES UNTIL SUCH TIMES AS PERSONS CAN LEAVE THE AREA PD TEST DATA INDICATE THAT THE RADIATION LEVEL CMA I E CMA THE RATE OF EXPOSURE CMA INDOORS ON THE FIRST FLOOR OF AN ORDINARY FRAME HOUSE IN A FALLOUT AREA WOULD BE ABOUT ONE-HALF THE LEVEL OUT OF DOORS PD EVEN GREATER PROTECTION WOULD BE AFFORDED BY A BRICK OR STONE HOUSE PD TAKING SHELTER IN THE BASEMENT OF AN AVERAGE RESIDENCE WOULD REDUCE THE RADIATION LEVEL TO ABOUT ONE-TENTH THAT EXPERIENCED OUT OF DOORS PD SHELTER IN AN OLD-FASHIONED CYCLONE CELLAR CMA WITH A COVERING OF EARTH THREE FEET THICK CMA WOULD REDUCE THE RADIATION LEVEL TO ABOUT 1/5000 CMA OR DOWN TO A LEVEL COMPLETELY SAFE CMA IN EVEN THE MOST HEAVILY CONTAMINATED AREA PD DESIGNS OF SHELTERS OF SIMPLE YET EFFECTIVE CONSTRUCTION HAVE BEEN PREPARED BY THE CIVIL DEFENSE ADMINISTRATON AND ARE AVAILABLE TO THE PUBLIC PD

27. RADIOACTIVE MATERIAL DEPOSITED DURING FALLOUT MAY OR MAY NOT BE VISIBLE BUT WOULD BE REVEALED BY RADIATION

END PAGE 8

PAGE 9

DETECTION INSTRUMENTS SUCH AS GEIGER COUNTERS PD ANY FALLING DUST OR ASH THAT CAN BE SEEN DOWN-WIND WITHIN A FEW HOURS AFTER A NUCLEAR EXPLOSION SHOULD BE REGARDED AS RADIOACTIVE UNTIL MEASURED BY A RADIATION DETECTION INSTRUMENT AND FOUND TO BE HARMLESS PD

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28. CARE SHOULD BE TAKEN TO AVOID THE USE OF SOLID FOODS OR LIQUIDS THAT MAY CONTAIN FALLOUT PARTICLES PD

29. IF FALLOUT PARTICLES COME INTO CONTACT WITH THE SKIN CMA HAIR OR CLOTHING CMA PROMPT DECONTAMINATION PRECAUTIONS SUCH AS HAVE BEEN OUTLINED BY THE FEDERAL CIVIL DEFENSE ADMINISTRATION WILL GREATLY REDUCE THE DANGER PD THESE INCLUDE SUCH SIMPLE MEASURES AS THOROUGH BATHING OF EXPOSED PARTS OF THE BODY AND A CHANGE OF CLOTHING PD

30. IF PERSONS IN A HEAVY FALLOUT AREA HEEDED WARNING OR NOTIFICATION OF AN ATTACK AND EVACUATED THE AREA OR AVAILED THEMSELVES OF ADEQUATE PROTECTIVE MEASURES CMA THE PERCENTAGE OF FATALITIES WOULD BE GREATLY REDUCED EVEN IN THE ZONE OF HEAVIEST FALLOUT PD

FALLOUT FROM NEVADA TESTS

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31. ONLY RELATIVELY SMALL NUCLEAR TEST EXPLOSIONS ARE CONDUCTED AT THE NEVADA TEST SITE CMA IN CONTRAST TO THE TESTS OF HIGH-YIELD THERMONUCLEAR DEVICES AT THE PACIFIC PROVING GROUNDS PD IN NEVADA CMA AS WELL AS IN THE PACIFIC CMA ALL TESTS ARE PLANNED FOR TIMES WHEN FORECAST WEATHER CONDITIONS MINIMIZE THE POSSIBILITY OF FALLOUT HAZARD PD METHODS OF FORECASTING WEATHER PATTERNS IN THESE AREAS ARE IMPROVING STEADILY PD HIGH AIR BURSTS AT THE NEVADA TEST SITE HAVE PRODUCED NO SIGNIFICANT FALLOUT SEMICLN HEAVY FALLOUT FROM NEAR-SURFACE EXPLOSIONS HAS EXTENDED ONLY A FEW MILES FROM THE POINT OF BURST PD THE HAZARD HAS BEEN SUCCESSFULLY CONFINED TO THE CONTROLLED AREA OF THE TEST SITE PD THE HIGHEST ACTUAL DOSE OF RADIATION AT AN OFF-SITE COMMUNITY HAS BEEN ESTIMATED TO BE LESS THAN ONE-THIRD OF THE GREATEST AMOUNT OF RADIATION WHICH ATOMIC ENERGY WORKERS ARE PERMITTED TO RECEIVE EACH YEAR UNDER THE ATOMIC ENERGY COMMISSION"S CONSERVATIVE SAFETY STANDARDS PD

INTERNAL RADIATION EFFECTS

32. SEVERAL BASIC FACTS SHOULD BE KEPT IN MIND IN EVALUATING THE HAZARD FROM FALLOUT RADIATION PD FIRST CMA RADIATION

END PAGE 9

PAGE 10

IS NOT A NEW PHENOMENON CREATED BY THE EXPLOSIONS OF FISSION AND THERMONUCLEAR WEAPONS PD SINCE THE BEGINNING OF LIFE CMA LIVING THINGS HAVE BEEN EXPOSED CONSTANTLY TO RADIATION FROM NATURAL SOURCES PD COSMIC RAYS FROM SPACE CONSTANTLY PASS THROUGH OUR BODIES PD WE ARE EXPOSED TO "BACKGROUND" RADIATION FROM RADIUM AND RADON IN THE SOIL CMA WATER AND AIR PD OUR BODIES HAVE ALWAYS CONTAINED NATURALLY RADIOACTIVE POTASSIUM AND CARBON PD

33. AS POINTED OUT EARLIER CMA DETONATIONS OF ALL ATOMIC WEAPONS PRODUCE RADIOACTIVITY CMA A PORTION OF WHICH IS CARRIED TO HIGH ALTITUDES AND OVER GREAT DISTANCES IN THE FORM OF FINE PARTICLES PD THE PERCENTAGE OF THIS RADIOACTIVITY WHICH TRAVELS BEYOND THE RELATIVELY NEAR AREA OF THE EXPLOSION DEPENDS LARGELY ON THE CONDITIONS UNDER WHICH THE BOMB IS FIRED CMA THE PERCENTAGE BEING HIGHER FOR IN-THE-AIR BURSTS WHERE THE FIRE-BALL DOES NOT TOUCH THE EARTH"S SURFACE PD THE MOST WIDESPREAD RADIOACTIVITY IS PRODUCED ONLY BY THE LONGER-LIVED FISSION PRODUCTS CMA SINCE THE RADIOACTIVITY OF THE SHORTER-LIVED PRODUCTS DECAYS AND DISAPPEARS BEFORE THE PARTICLES COME DOWN TO EARTH IN A MATTER DAYS CMA WEEKS CMA MONTHS CMA AND EVEN YEARS PD THE LONGER-LIVED RADIOACTIVE PRODUCTS MAY BE DISTRI-BUTED OVER THE ENTIRE EARTH PD HOWEVER CMA AS THE PARTICLES ARE

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CARRIED FARTHER AND FARTHER TO REMOTE AREAS CMA THE POSSIBILITY OF SIGNIFICANT AMOUNTS OF FALLOUT DECREASES PD

RADIOSTRONTIUM FALLOUT

34. ONE OF THE MOST BIOLOGICALLY IMPORTANT RADIOACTIVE SUBSTANCES FOUND IN FALLOUT IS STRONTIUM-90 PD IT HAS A LONG LIFETIME--NEARLY 30 YEARS ON THE AVERAGE PD RADIOSTRONTIUM HAS A CHEMICAL SIMILARITY TO CALCIUM AND CMA THEREFORE CMA WHEN TAKEN INTO THE BODY IT HAS A TENDENCY TO COLLECT IN THE BONES PD RADIOSTRONTIUM CAN ENTER THE BODY IN TWO WAYS -- BY INHALING OR BY SWALLOWING PD NORMALLY CMA THE AMOUNT INHALED WOULD BE SMALL COMPARED WITH THE AMOUNT ONE MIGHT SWALLOW PD FALLOUT MATERIAL DEPOSITED DIRECTLY ON EDIBLE PARTS OF PLANTS MAY BE EATEN ALONG WITH THE PLANTS CMA BUT WASHING THE PLANTS BEFORE THEY ARE EATEN WOULD REMOVE MOST OF THIS RADIOACTIVE MATERIAL PD HOWEVER CMA RAINFALL CARRYING THE RADIOSTRONTIUM DOWN TO EARTH MAY DEPOSIT IT IN THE SOIL WHERE IT CAN BE TAKEN UP CMA IN PART CMA BY PLANTS AND INCORPORATED INTO PLANT TISSUES CMA LATER TO BE EATEN BY HUMANS OR BY GRAZING ANIMALS WHICH CMA IN TURN CMA PROVIDE FOOD FOR HUMANS PD

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END PAGE 10

35. SINCE THE START OF NUCLEAR TESTS CMA CAREFUL MEASUREMENTS HAVE BEEN MADE OF THE DISTRIBUTION OF RADIOSTRONTIUM OVER THE EARTH"S SURFACE CMA IN THE SOILS CMA IN PLANTS AND ANIMAL TISSUES CMA IN THE OCEANS CMA IN RAIN CMA IN THE ATMOSPHERE AND IN ALL FORMS IN WHICH IT MIGHT BE EXPECTED TO OCCUR PD THE RESULTS OF THIS STUDY ARE REASSURING PD THE AMOUNT OF RADIOSTRONTIUM NOW PRESENT IN THE SOIL AS A RESULT OF ALL NUCLEAR EXPLOSIONS TO DATE WOULD HAVE TO BE INCREASED MANY THOUSAND TIMES BEFORE ANY EFFECT ON HUMANS WOULD BE NOTICEABLE PD

RADIOIODINE FALLOUT

36. AMONG THE SHORTER-LIVED FISSION PRODUCTS INVOLVED IN THE STUDY OF INTERNAL RADIATION CMA THE BIOLOGICALLY IMPORTANT RADIOIODINE-131 WITH AN AVERAGE LIFE OF ONLY 11.5 DAYS PD EVEN THOUGH THIS PRODUCT MAY BE WIDELY SPREAD AFTER A NUCLEAR EXPLOSION CMA THE POSSIBILITY OF SERIOUS HAZARD IS LIMITED BY ITS RELATIVELY SHORT LIFE PD LIKE THE NON-RADIOACTIVE FORM OF THE ELEMENT CMA IT CONCENTRATES IN THE THYROID GLAND AND CMA IN EXCESSIVE QUANTITY CMA CONCEIVABLY COULD DAMAGE THE THYROID CELLS PD

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37. SCIENTISTS OF THE ATOMIC ENERGY COMMISSION HAVE ESTIMATED THAT THE AVERAGE EXPOSURE OF PEOPLE IN THE UNITED STATES FROM RADIOIODINE IN THE FALLOUT FROM THE ENTIRE SERIES OF TESTS IN THE SPRING OF 1954 WAS ONLY A FEW PERCENT OF THE ANNUAL DOSE THAT CAN BE RECEIVED YEAR AFTER YEAR AND STILL HAVE

NO NOTICEABLE EFFECTS PD

38. THESE TWO ISOTOPES -- RADIOSTRONTIUM AND RADIO-IODINE -- CONSTITUTE THE PRINCIPAL INTERNAL HAZARDS FROM THE RADIOACTIVITIES PRODUCED BY THE DETONATIONS OF ATOMIC WEAPONS CMA BOTH FISSION AND THERMONUCLEAR PD THE ATOMIC ENERGY COMMISSION HAS BEEN ENGAGED FOR THREE YEARS IN A BROAD STUDY OF THE RADIO-ACTIVE FORMS OF THESE ISOTOPES AND CONDUCTS YEAR-ROUND MONITORING OF THESE RADIOACTIVITIES IN MANY LOCATIONS PD ANY ACCUMULATION OF THESE MATERIALS CAN BE DETECTED WITH GREAT SENSITIVITY SO THAT AMPLE WARNING OF POTENTIAL HAZARD COULD BE GIVEN LONG BEFORE ANY ACTUAL DANGER OCCURRED FROM TEST DETONATIONS PD THE AMOUNTS OF RADIOSTRONTIUM AND RADIOIODINE WHICH HAVE FALLEN OUTSIDE THE AREAS NEAR THE TEST SITES AS A RESULT OF ALL ATOMIC TESTS UP TO NOW ARE INSIGNIFICANT COMPARED TO CONCENTRATIONS THAT WOULD BE CONSIDERED HAZARDOUS TO HEALTH PD

END PAGE 11

PAGE 12

GENETIC EFFECTS OF RADIATION

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39. ONE OTHER EFFECT OF RADIATION MUST BE CONSIDERED IN EVALUATING THE LONG-RANGE POSSIBILITIES OF HAZARD FROM NUCLEAR DETONATIONS PD THIS IS THE POSSIBLE GENETIC EFFECT UPON THE GERM CELLS WHICH TRANSMIT INHERITED CHARACTERISTICS FROM ONE GENERATION

TO ANOTHER PD AT OUR PRESENT STAGE OF GENETIC KNOWLEDGE CMA THERE IS A RATHER WIDE RANGE OF ADMISSIBLE OPINION ON THIS SUBJECT PD

40. IN GENERAL CMA THE TOTAL AMOUNT OF RADIATION RECEIVED BY RESIDENTS OF THE UNITED STATES FROM ALL NUCLEAR DETONATIONS TO DATE CMA INCLUDING THE RUSSIAN AND BRITISH TESTS AND ALL OF OUR OWN TESTS IN THE UNITED STATES AND THE PACIFIC CMA HAS BEEN ABOUT ONE-TENTH OF ONE ROENTGEN PD THIS IS ONLY ABOUT 1/100TH OF THE AVERAGE RADIATION EXPOSURE INEVITABLY RECEIVED FROM NATURAL CAUSES BY A PERSON DURING HIS OR HER REPRODUCTIVE LIFETIME PD IT IS ABOUT THE SAME AS THE EXPOSURE RECEIVED FROM ONE CHEST X-RAY PD

41. THE MEDICAL AND BIOLOGICAL ADVISERS OF THE ATOMIC ENERGY COMMISSION BELIEVE THAT THE SMALL AMOUNT OF ADDITIONAL EXPOSURE OF THE GENERAL POPULATION OF THE UNITED STATES FROM OUR NUCLEAR WEAPONS TESTING PROGRAM WILL NOT SERIOUSLY AFFECT THE GENETIC CONSTITUTION OF HUMAN BEINGS PD NEVERTHELESS CMA WE ARE CONTINUING OUR THOROUGH STUDY OF THE ENTIRE QUESTION AND WILL CONTINUE TO REPORT OUR FINDINGS TO THE AMERICAN PEOPLE PD

SUMMARY

42. THE ATOMIC ENERGY COMMISSION HOPES THAT THE INFORMATION ON NUCLEAR WEAPONS EFFECTS CONTAINED IN THE FOREGOING REPORT WILL NEVER BE REFLECTED IN HUMAN EXPERIENCE AS THE RESULT OF WAR PD HOWEVER CMA UNTIL THE POSSIBILITY OF AN ATOMIC ATTACK IS ELIMINATED BY A WORKABLE INTERNATIONAL PLAN FOR GENERAL DISARMAMENT CMA THE STUDY AND EVALUATION OF WEAPONS EFFECTS AND CIVIL DEFENSE PROTECTION MEASURES MUST BE A NECESSARY DUTY OF OUR GOVERNMENT PD

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43. INEVITABLY CMA A CERTAIN ELEMENT OF RISK IS INVOLVED IN THE TESTING OF NUCLEAR WEAPONS CMA JUST AS THERE IS SOME RISK IN MANUFACTURING CONVENTIONAL EXPLOSIVES OR IN TRANSPORTING

INFLAMMABLE SUBSTANCES SUCH AS OIL OR GASOLINE ON OUR STREETS AND HIGHWAYS PD THE DEGREE OF RISK MUST BE BALANCED AGAINST THE GREAT IMPORTANCE OF THE TEST PROGRAMS TO THE SECURITY OF

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THE NATION AND OF THE FREE WORLD PD HOWEVER CMA THE DEGREE OF HAZARD CAN BE EVALUATED WITH CONSIDERABLE ACCURACY AND TEST CONDITIONS CAN BE CONTROLLED TO HOLD IT TO A MINIMUM PD NONE OF THE EXTENSIVE DATA COLLECTED FROM ALL TESTS SHOWS THAT RESIDUAL RADIOACTIVITY IS BEING CONCENTRATED IN DANGEROUS AMOUNTS ANYWHERE IN THE WORLD OUTSIDE THE TESTING AREAS PD

44. IN THE EVENT OF WAR INVOLVING THE USE OF ATOMIC WEAPONS CMA THE FALLOUT FROM LARGE NUCLEAR BOMBS EXPLODED ON OR NEAR THE SURFACE WOULD CREATE SERIOUS HAZARDS TO CIVILIAN POPULATIONS IN LARGE AREAS OUTSIDE THE TARGET ZONES PD HOWEVER CMA AS MENTIONED IN THE FOREGOING REPORT CMA THERE ARE MANY SIMPLE AND HIGHLY EFFECTIVE PRECAUTIONARY MEASURES WHICH MUST BE TAKEN BY INDIVIDUALS TO REDUCE CASALITIES TO A MIMIMUM OUTSIDE THE IMMEDIATE AREA OF COMPLETE OR NEAR-COMPLETE DESTRUCTION BY BLAST AND HEAT PD MANY OF THESE PROTECTIVE MEASURES CMA SUCH AS SHELTER AND DECONTAMINATION PROCEDURES CMA HAVE BEEN DETAILED BY THE FEDERAL CIVIL DEFENSE ADMINSTRATION PD

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